PROPERTIES, CLASSIFICATION, AND GENETIC INTERPRETATION OF THE ALLOCHTHONOUS IMPACT FORMATIONS OF THE ICDP CHICXULUB DRILL CORE YAX-1. D. Stöffler, L. Hecht, T. Kenkmann, R. T. Schmitt, and A. Wittmann, Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität zu Berlin, Invalidenstr. 43, 10099 Berlin, Germany; e-mail: dieter.stoeffler@rz.hu-berlin.de

Introduction: The ICDP drilling YAX-1 (Yaxcopoil-1), located some 60 km south of the Chicxulub impact center, penetrated to a depth of 1510 m. Below 795 m of Tertiary post-impact sediments 100 m of allochthonous impact breccias occur which consist of impact melt particles mixed with lithic and mineral clasts derived from the complete excavated target section: Panafrican crystalline basement to Cretaceous carbonate and sulfate rocks. These breccias fulfill the definition of suevite: Polymict clastic matrix breccia with cogenetic melt particles [1]. We report here first results of an analysis of the 100 m thick section of allochthonous impact breccias. Results of related studies are given in companion abstracts [2-5].

Samples and methods: Some 40 core samples (2–6 cm of quarter and half core sections) were studied by optical, electron optical (SEM), XRF, and microprobe analyses. Digital photos of the uncut and cut cores and whole thin section photos were intensively used for textural and fabric analyses.

Results: *Petrographic composition and texture of breccias***.** The impactites (794.63 – 894.94 m) represent a complex layered sequence of suevite-type polymict breccias which are extremely rich in sub-mm to dm sized melt particles and rather poor in fine-grained matrix (compared to typical suevite from smaller craters [1,6,7]). They contain variably shocked lithic clasts from crystalline and sedimentary rocks. The matrix is calcite-rich and appears to have replaced a primary clastic matrix by secondary mineralisation [3]. The modal composition, the grain size of the components, and the matrix characteristics of the impactites are distinctly variable with depth and allow to establish 6 different layers (units 1–6). Their characteristics and a proposal for the classification and nomenclature are given in Tables 1 and 2.

Chemical properties of breccias. The whole rock chemistry reflects clearly that the various units of suevite-type breccias represent mixtures of crystalline rocks and Cretaceous carbonate rocks (mainly limestones) (Figs. 1, 2). The anhydrite component which is a major lithology in the megablock section of the core [4], is missing or negligible (SO_3-contents: mostly < 0.1 wt.%, rarely up to 0.5 wt.%). The distinct anticorrelation of the SiO_2 and CaO-contents (Figs. 1, 2) demonstrates that the suevite section is a mixture of 2 components: Predominant crystalline rocks and subordinate limestone. Their relative abundances vary only slightly except for units 4 and 6 which are more enriched in carbonate. The former component is mainly represented by the silicate melt particles which appear to have an bulk "granodioritic", mixed chemistry (SiO_2: ~ 55-62 wt.%).

Impact melts. Silicate and carbonate melts were found which are all crystallized (plagioclase, pyroxene, sheet silicates, calcite). The silicate melt occurs in discrete particles whereas the carbonate melt forms (1) exsolved inclusions in silicate melts of all units and (2) larger bodies of polycrystalline Mg-bearing calcite, the latter mainly in unit 6 (Lower Suevite) at the contact to the limestone megablock.

Table 1: Proposed stratigraphy and nomenclature of impactites of the ICDP drill core YAX-1, Chicxulub, Yucatan, Mexico

Depth* (m)	Log name** (unit)	Proposed name
Allochthonous polymict impact breccias		
794.63 – 807.75	Redeposited suevite (1)	**Upper sorted suevite (USS)**
807.75 – 823.25	Suevite (2)	**Lower sorted suevite (LSS)**
823.25 – 846.09	Chocolate-brown "melt" breccia (3)	**Upper suevite (US)**
846.09 – 861.06	Suevitic breccia, variegated, glass-rich (4)	**Middle suevite (MS)**
861.06 – 884.96	Green monomict-autogene melt breccia (5)	**Suevitic breccia with cataclastic melt rock (SB)**
884.96 – 894.94	Variegated polymict, allogenic-clast melt breccia (6)	**Lower suevite (LS)**
Parautochthonous target rocks with monomict cataclastic breccia and dike breccias		
894.94 – 1510.97	Cretaceous (7)	**Megablock(s) of carbonate and sulfate rocks**

* note that some values deviate slightly from the macroscopic division (B. O. Dressler), **according to B. O. Dressler

Conclusions: Yaxcopoil-1 provides for the first time a complete section through the annular trough (megablock zone) of one of the 3 terrestrial multi-ring basins. The results available so far are fundamental for the understanding of the conditions and dynamics of the ejecta plume.

Table 2: Classification, stratigraphy, properties, and interpretation of the allochthonous impactites of the ICDP drill core YAX-1, Chicxulub, Yucatan, Mexico (see Table 1 for abbreviations and depths)

Unit	Petrographic properties	Genetic interpretation
USS (1)	Suevite, sorted, melt-rich, fine grained; clastic matrix	Air fall deposit with aquatic sedimentation
LSS (2)	Suevite, sorted, melt-rich, coarse grained; clastic matrix, partly recryst.	Air fall deposit
US (3)	Suevite, melt rich, carbonate-poor, very coarse grained; recrystallized matrix	Fall back suevite
MS (4)	Suevite, melt rich, carbonate-rich, very coarse grained; re-crystallized matrix	Fall back suevite
SB (5)	Suevitic melt agglomerate with monomictly brecciated melt bodies, coarse grained; crystallized matrix (remelted)	Relocated coherent melt rock mixed with suevite components
LS (6)	Suevite with silicate and carbonate melt, melt-rich, very coarse grained; recrystallized matrix	Ground-surged suevite

The petrographic and chemical properties of the suevite-type section indicate that the source material is from the deepest excavation zone and was incorporated into the ejecta plume at a late stage when the bulk of the high rising plume (including the main mass of the vaporized/melted projectile) had disappeared from the impact site [5] and distributed globally [8, 9]. Some of he silicate impact melt contained in the breccias originated from a region of the melt zone which got mixed with carbonate melt, homogenized, and ejected into the plume. It exsolved Ca-carbonate melt during fast cooling in the fall back phase and crystallized plagioclase and pyroxene at very low pH_2O. A slow cooling phase followed after deposition at high pH_2O inducing hydrothermal conditions (e.g., sheet silicate formation and K-metasomatism [3]).

We believe that only the upper section (units 1-4; Table 2) represent ballistic "fallout" material from the ejecta plume. Because of the unique properties of units 5 and 6 the Lower Suevite (unit 6) was not air-borne but ground surged material deposited as the first layer and then covered with laterally inward moving and brecciated material (suevitic breccia with cataclastic melt rock) from a tongue of coherent melt which probably had been deposited and quenched near to the peak ring. Units 4, 3, 2, and 1 were deposited in this sequence as fallback material later than units 6 and 5. The grain size sorting of units 2 and 1 may be due to the combined effects of the atmosphere reentering the crater region and aquatic sedimentation.

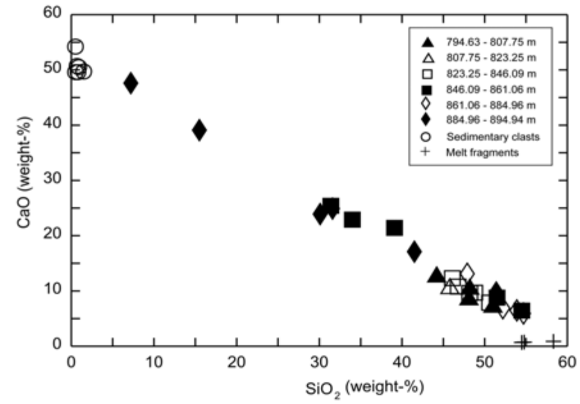

Fig. 1: XRF analyses of allochthonous impactites of YAX-1 drill core; "melt fragments" are averages of 28, 2, and 4 EMP analyses at 800.25, 808.87, and 824.01 m depth, respectively; sedimentary clasts are from ~ 885 m depth

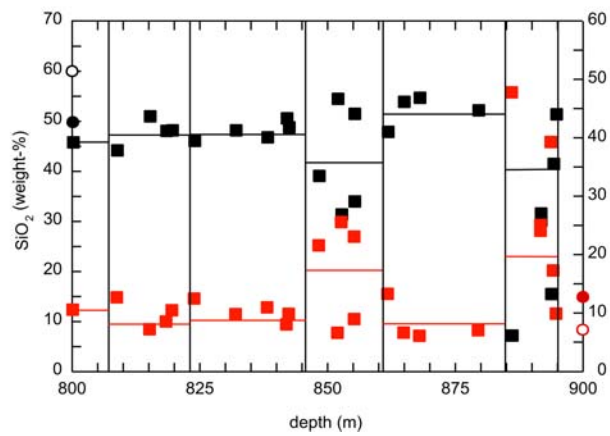

Fig. 2: XRF analyses of all suevite-type units of the YAX-1 drill core. Suevite (filled circles) and coherent melt rock (open circles) of the PEMEX Y6 and C1 drill cores (averages) are plotted for comparison; see also [10]

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